Permitting Roadmap for Seawater Desalination Facilities in Texas Using Reverse Osmosis Processes

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Introduction

The issues associated with permitting seawater desalination facilities using reverse osmosis ("RO") processes can be complex and confusing. Since only a limited number of actual facilities with regulatory approval are available for use as models in the United States, there is also limited stakeholder guidance for permitting. In fact, the lack of guiding precedent and the resultant uncertainty that regulators face when making decisions related to permit conditions are often cited as major impediments to the successful implementation of desalination projects.

The purpose of this paper is to present an overview of a permitting roadmap for seawater desalination facilities in Texas using RO processes. The roadmap has been constructed so it can be used to identify the major applicable permitting requirements in an orderly and methodical manner, once the primary facility features are defined. A seawater desalination facility that is co-located with a power plant is used an example to demonstrate the model. As shown by the example, this model can be an effective tool once the specific features affecting permitting for any given project have been identified. In addition, the model can serve as an aid for defining specific project features affecting permitting.

Major Facility Features Affecting Permitting

Seawater desalination facilities using RO processes facilities all share some common features. They include a seawater intake system, a reverse osmosis treatment process, and a means for concentrate disposal. In addition, they usually require a transmission pipeline to convey the product water to the municipal bulk storage or distribution system. As a result, the major regulatory issues associated with these types of facilities generally include a needs assessment for the facility, seawater intake impacts, concentrate disposal effects, construction impacts, and product water transmission pipeline routing. These project aspects should be defined in the early stages of project planning so that: 1) their impact on permitting requirements can be assessed; 2) mitigating features can be included in the project design, and 3) their effects on project economics can be evaluated.

Other regulatory issues also often exist, since these facilities typically have ancillary features such as membrane cleaning systems, backup power, chemical storage silos, wastewater treatment systems, and storm water collection and control systems. As a result, issues related to waste disposal and air emissions must be considered as well.

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Raw Water Intake

Seawater facilities typically use surface water as a raw water source. A surface water intake usually consists of a direct intake of surface water through a series of screens, weirs and pumps. The intake structure can be floating or fixed. The design typically must consider environmental issues such as aquatic animal entrainment and mortality, as well as scouring effects, which can affect raw water turbidity levels and subsequently, pretreatment requirements. Consequently, the surface water intake design can be a critical aspect of the facility and could require an extensive Texas Commission on Environmental Quality ("TCEQ") evaluation.

One variation, which tends to mitigate the potential environmental issues, is to use an existing intake like that employed by a power plant with a once-through cooling water system. The surface water can then be withdrawn for the desalination facility after discharge from the power plant's condenser so that essentially no additional aquatic animal entrainment or mortality occurs due to the desalination facility intake. Additional advantages can include the use of the power plant's intake and discharge infrastructure, access to a source of heated water as raw water, and the possibility of blending the concentrate from the desalination process with the power plant's cooling water discharge.

Only certain power facilities are suitable as candidates for co-location. Typically, the operating regime and projected future service life of the power plant and the desalination facility must be compatible. The quality, quantity, and reliability of the power plant's cooling water also must be satisfactory for use by the desalination facility. Finally, the environmental impacts from the addition of a new desalination facility at the site must be acceptable. A power plant with multiple base load electric generating units is generally the best choice. This type of a power plant rarely goes offline and provides a reliable, constant source of power and a consistent cooling water flow for the desalination facility.

To determine if a power plant is a suitable candidate for co-location, it is suggested, as a minimum, that the following studies be conducted:

- Environmental studies for impacts of concentrate discharge, including:
    - The ability to blend with cooling water discharge water;
    - The impact of blended concentrate flow on receiving waters;
    - The impact from construction of pipelines and facilities
- An evaluation of power plant operation addressing:
    - The viability of the long-term plan for continued operation of power plant;
    - The power plant operating regime – base load with multiple electric generating units or other;
    - The footprint available for the desalination facility
- A raw water source evaluation including treatability;
- An evaluation of public perception and acceptance of the project at the subject location.

Groundwater Intake

Beach wells can provide a means for raw water intake in lieu of raw water surface intakes for seawater desalination facilities. However, beach wells are not typically expected to be employed in Texas, since co-location opportunities exist for desalination facilities with power plants that

have once-through cooling systems, and a groundwater intake is generally more expensive than a surface water intake.

Concentrate Disposal

The most common method for concentrate disposal for a seawater facility is direct surface water disposal. However, deep well injection is also a higher-cost alternative that could be employed if necessary. Both methods potentially have environmental impacts. Consequently, they are subject to environmental regulations and permit requirements.

Direct discharge to surface water would include discharge of the concentrate directly to the Gulf of Mexico, saline water, or other surface waters, as may be environmentally acceptable. Direct discharge methods also include blending with existing discharges from power plant cooling water or wastewater treatment facilities. Blending can be an effective mitigating measure for environmental impacts.

As another alternative, where feasible, concentrate beneficial reuse through the use of brine lines could also be considered. Typically, brine lines are used to inject brine as part of the extraction process of petroleum from the ground, and the brine re-injected.

Permitting Roadmap

Overview

As discussed above, facility features related to the selection of the site, the source of raw water, the concentrate disposal method, and the ancillary systems associated with waste disposal, wastewater discharges, and air emissions can have significant environmental impacts. In addition, other permits typically obtained through local government agencies, such as building permits, are necessary for all types of projects.

A roadmap for permitting is presented in Figure 1. This Figure, depicted as 11 separate components for convenience, presents a multi-step permit decision model that may be employed to define the major permitting requirements for these desalination facilities. It provides a systematic approach to identify major permit requirements via a set of decision tree analyses that may be used, once basic project features have been defined. It should be noted that the roadmap is generic, in that it may be applied to a facility that uses either seawater or brackish water as raw water. While brackish water facilities are not addressed in this paper, a general roadmap is provided so that this tool can be utilized on a more extensive basis than a model that considers seawater facilities only.

The roadmap is divided into three main modules. The first is associated with raw water source permitting. The second applies to the permits required for all facilities. The third is used for concentrate and membrane cleaning solution disposal methods. Once decisions have been reached about the raw water source for the facility, and how concentrate and membrane cleaning residuals disposal will be conducted, the responses to a series of yes-no questions provide the guidance needed to identify the major permits related to these processes. The module for permits required for all facilities addresses the permits needed for project development, new construction, environmental permits and other operating permits. Once again, a series of yes-no questions guides the user through the permit identification process.

Figure 1

Permitting Model Overview for
Desalination Facilities Using RO Technology in Texas

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

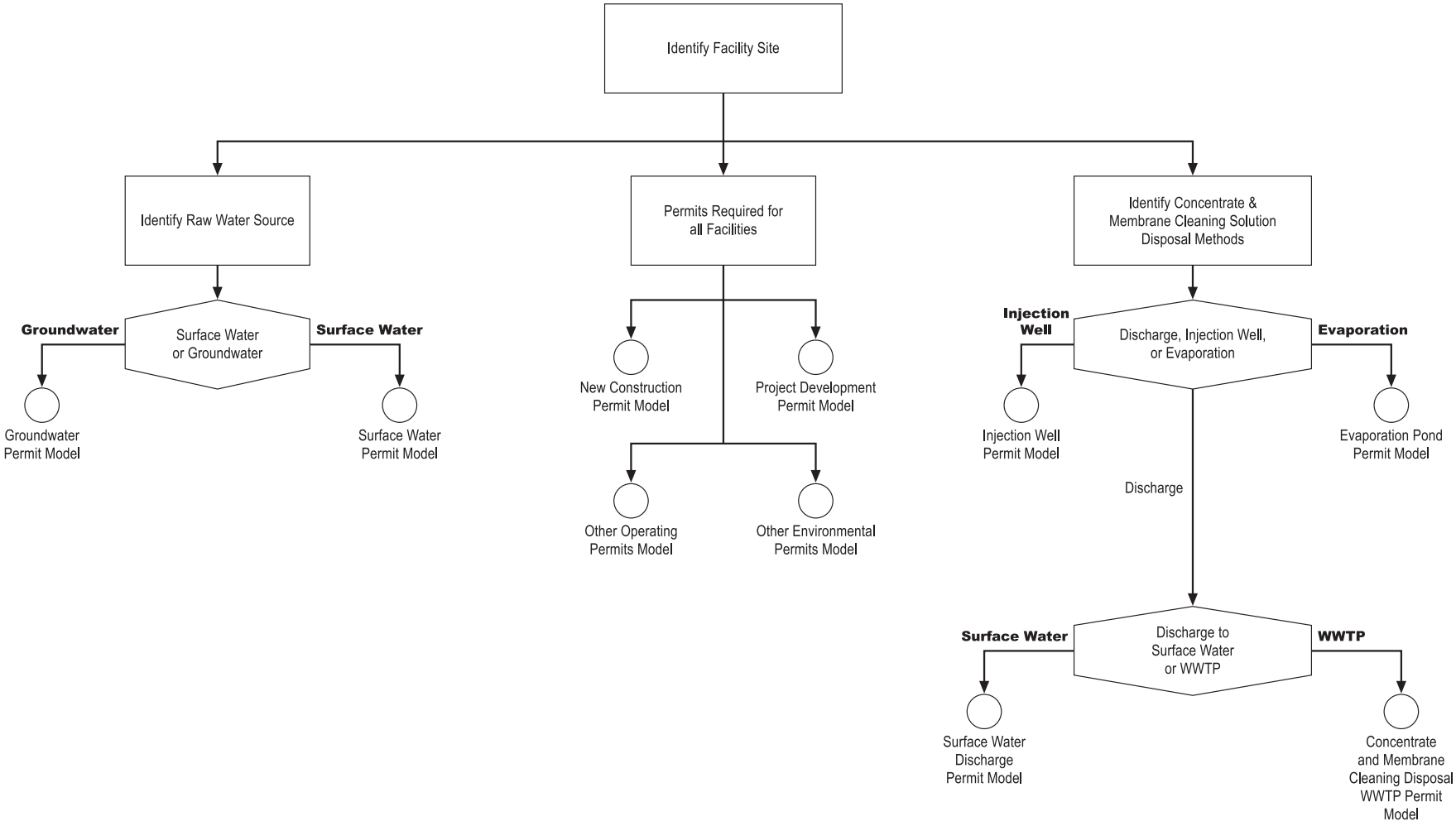


Figure 1

Groundwater Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

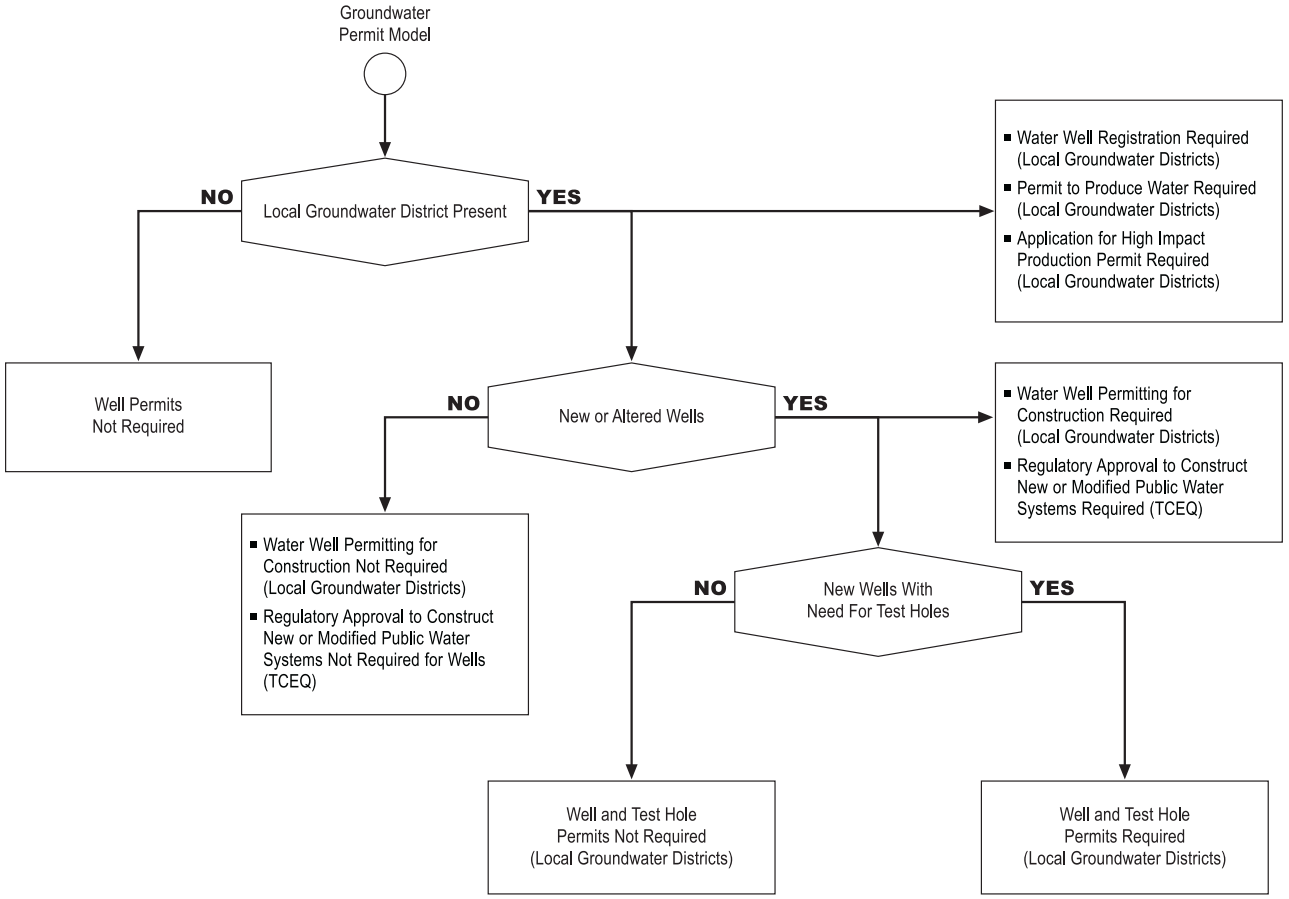


Figure 1

Surface Water Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

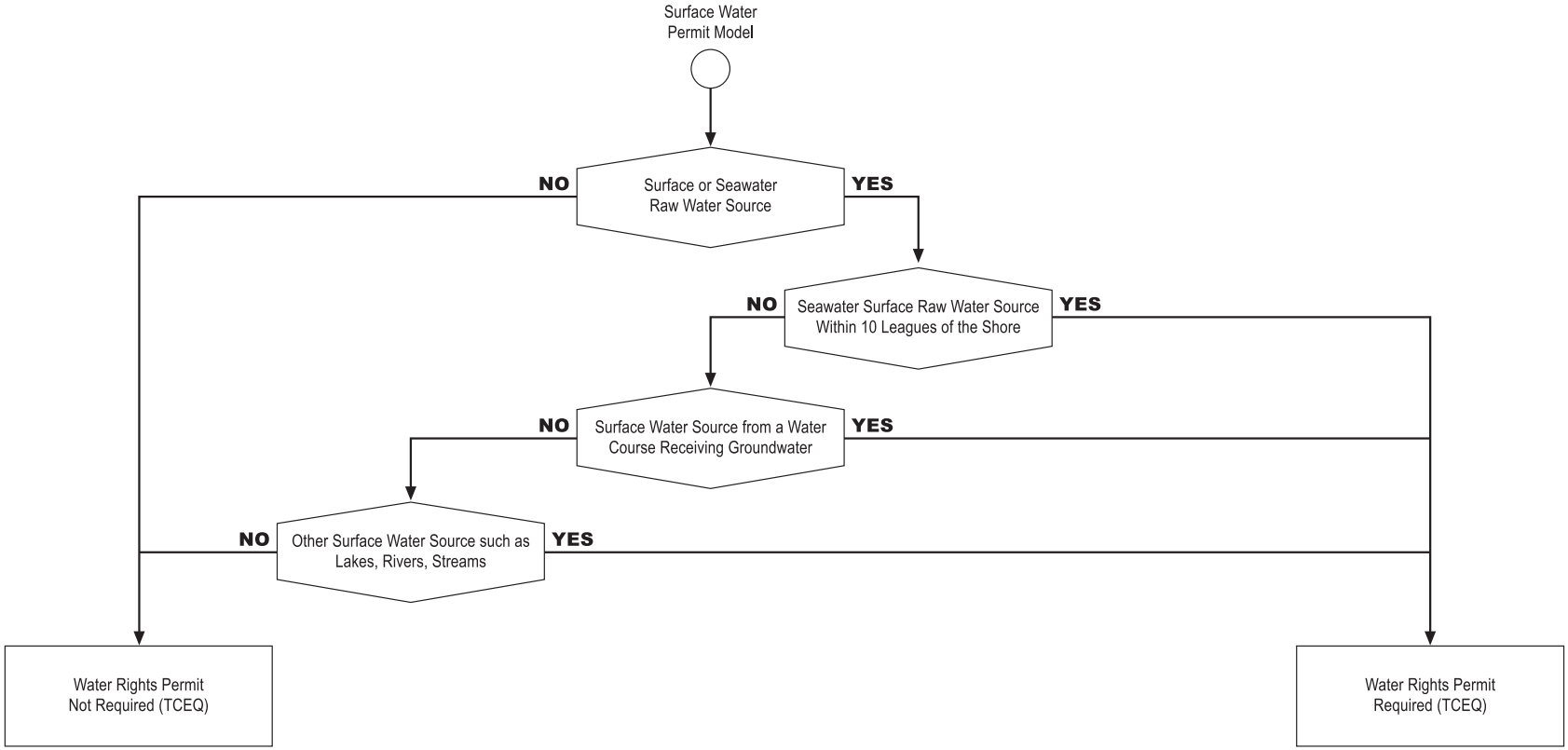


Figure 1

Other Operating Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

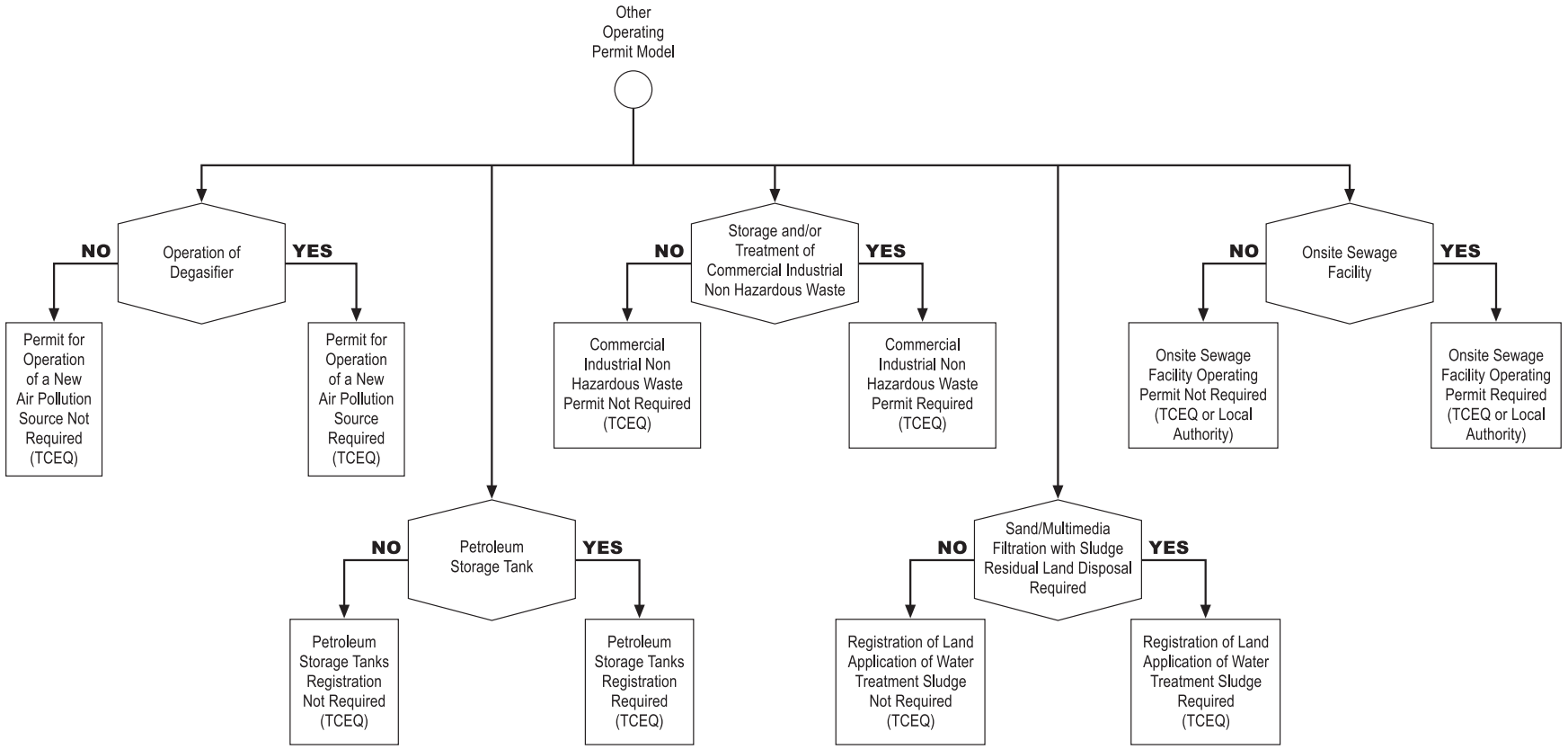


Figure 1

Other Environmental Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

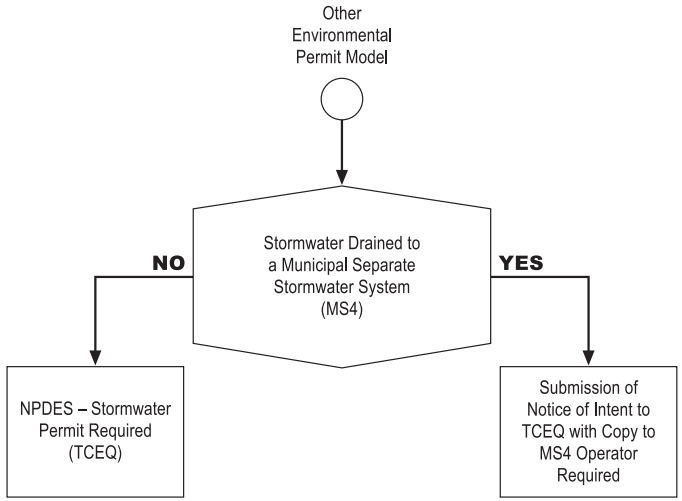


Figure 1

Project Development Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

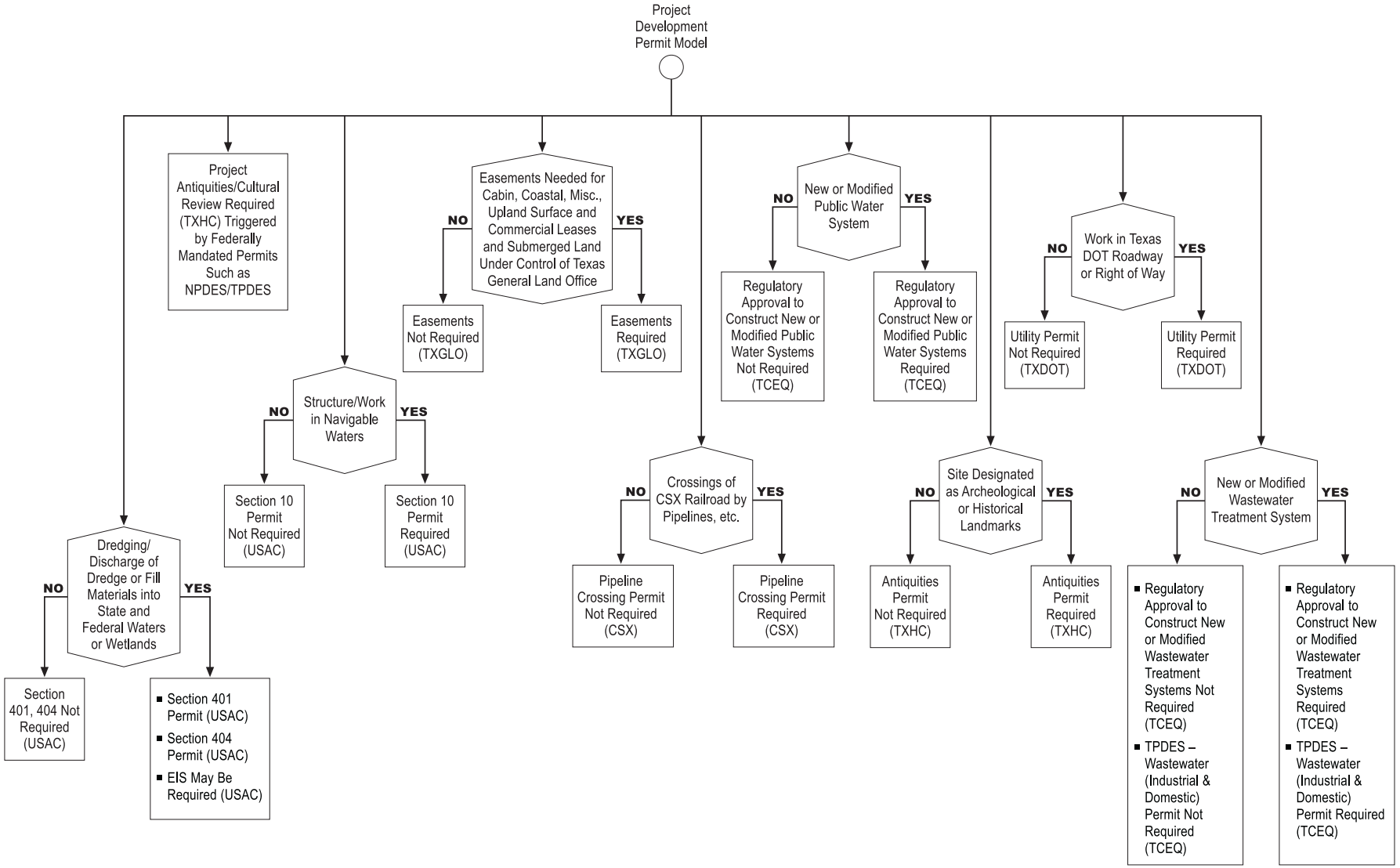


Figure 1

New Construction Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

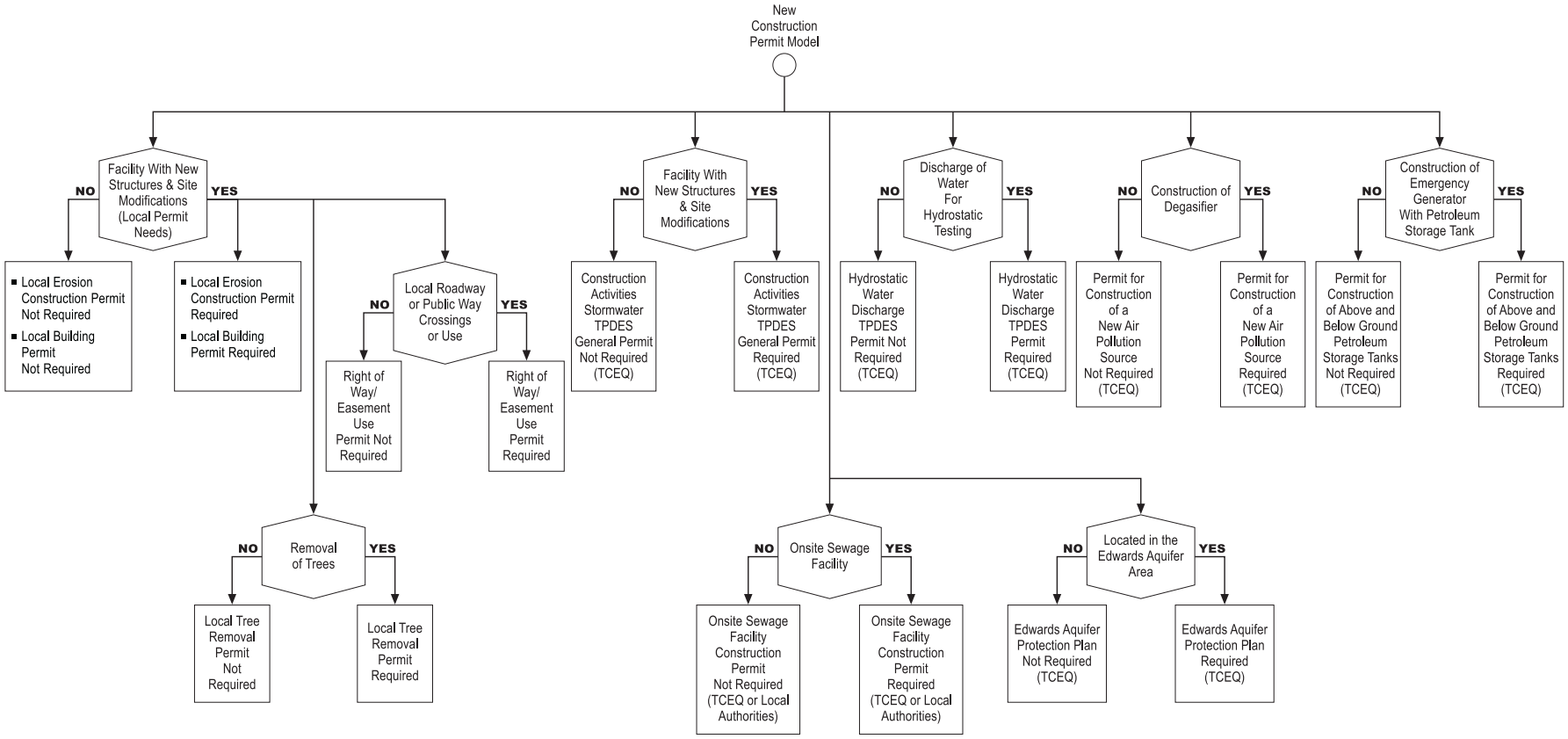


Figure 1

Concentrate Disposal
Injection Well Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

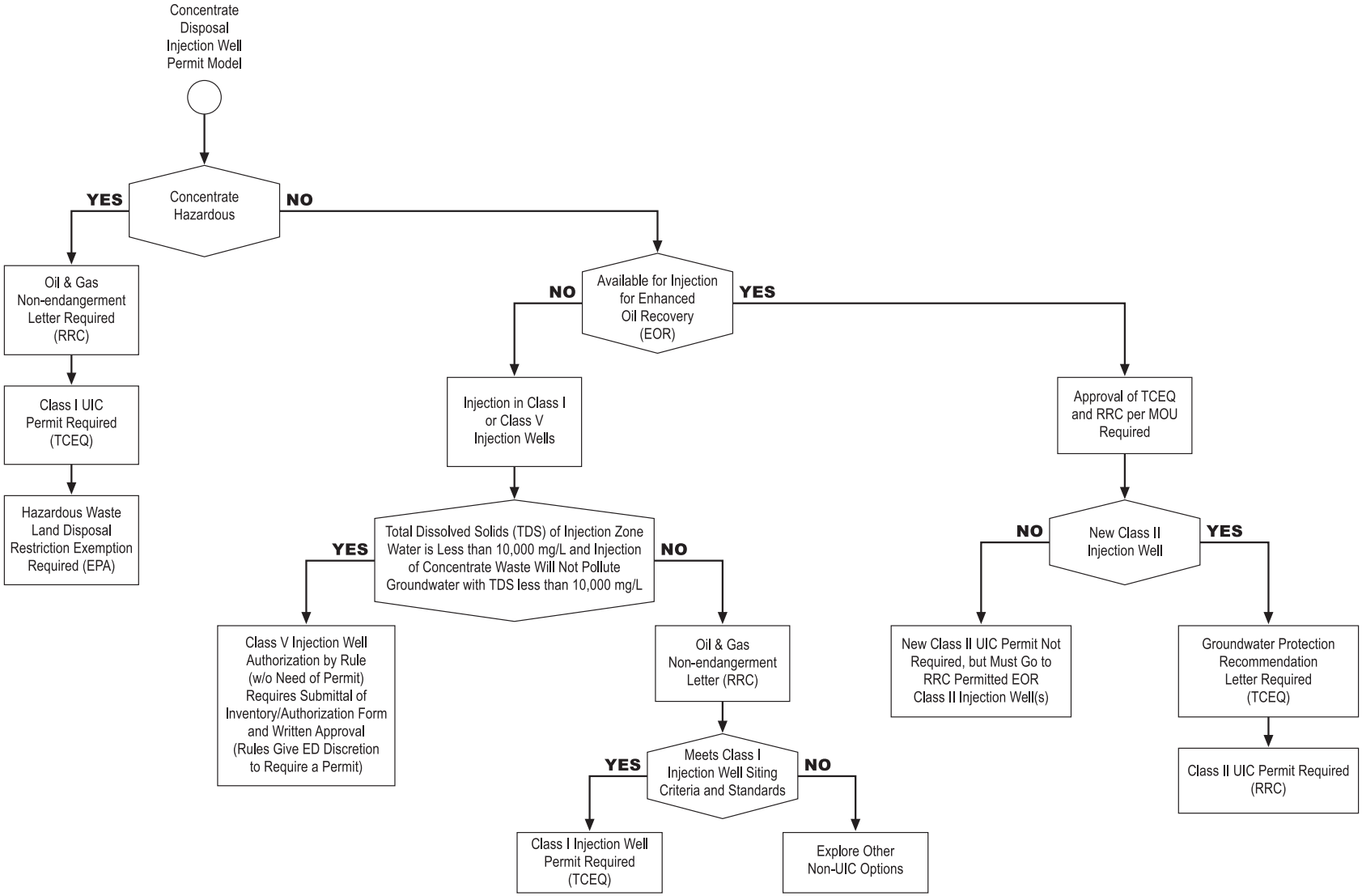


Figure 1

Concentrate Disposal
Surface Water Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

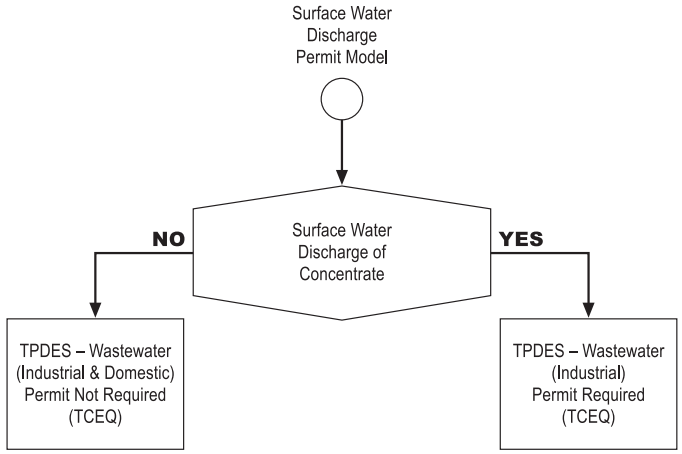


Figure 1

Concentrate and Membrane Cleaning Disposal
WWTP Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model

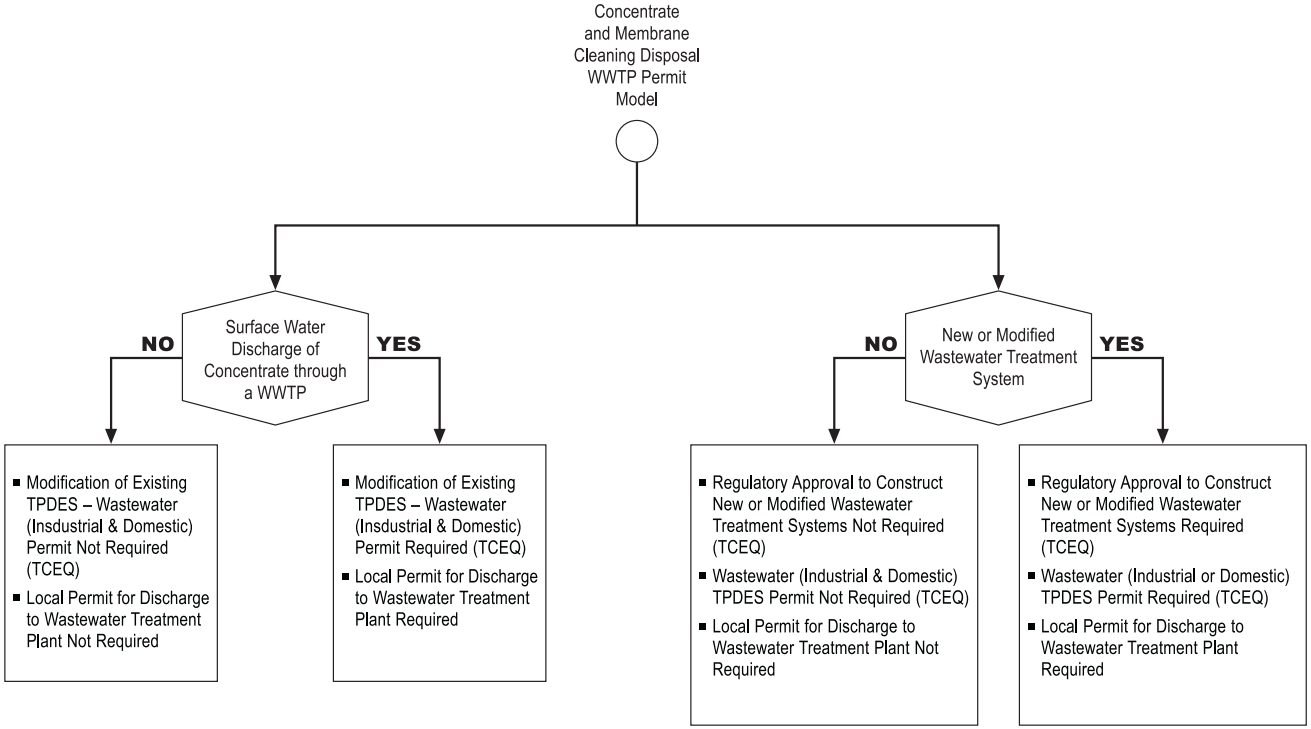
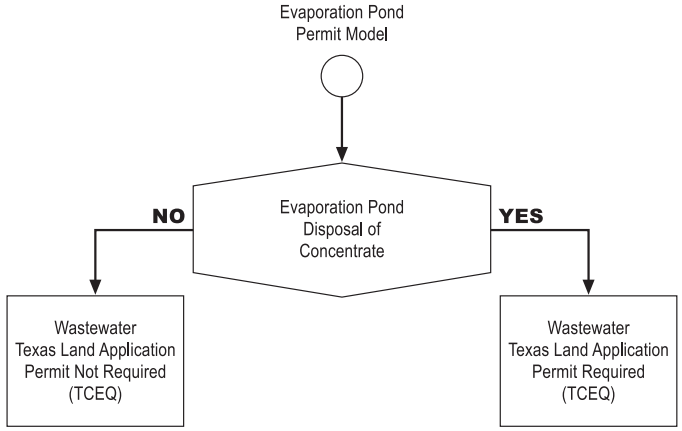


Figure 1

Concentrate Disposal
Evaporation Pond Permit Model

Texas Water Development Board Guidance Manual – Reverse Osmosis Desalination Facility Permit Model



Seawater Desalination Facility Example

An example illustrating the use of the roadmap by summarizing the permitting requirements for a typical seawater desalination facility that uses an RO process and is co-located with a power plant is provided below. For the purposes of this illustration, the permitting requirements are based on the following assumptions about major project features:

1. The power plant utilizes seawater as coolant for a once-through condenser cooling water process;
2. Surface water withdrawn from the power plant's condenser cooling water discharge will be used as a raw water source for the desalination facility;
3. Concentrate will be disposed via discharge into the power plant's condenser cooling water discharge at a location downstream of the raw water intake for the desalination facility;
4. Sewage will be discharged to a Publicly Owned Treatment Works ("POTW");
5. Storm water will be discharged to separate municipal storm water sewer for disposal;
6. Reverse Osmosis membrane cleaning wastes will be disposed via a POTW;
7. The project will include a new product water transmission pipeline.

Tables 1 and 2 present a summary of the permitting requirements for the seawater desalination facility described above, derived from the roadmap decision tree steps. Table 1 reflects the major permits for the desalination facility and Table 2 addresses the new product water transmission pipeline. In addition, the tables also present a listing of estimated permitting process time intervals for the major permits associated with the example. The permitting process time intervals are estimated as typical durations for these activities. As such, they are subject to variation depending on specific project circumstances.

Figure 2 consolidates the time interval information provided in Tables 1 and 2 into an overall permitting schedule. As shown, it is expected that the schedule for the TPDES permit would be a critical path component.

Obtaining the Water Rights Permit and the Approval for New or Modified Public Water System (Includes Pilot Test Data) can also be lengthy processes. Consultation with the TCEQ has indicated that challenges have the potential to extend Water Rights permitting to two years or longer. However, since the raw water source in this example is seawater, challenges due to prior water rights seem unlikely. Similarly, assuming that both the development tasks associated with facility needs assessment activities and an effective pilot testing program for the Approval for New or Modified Public Water System are conducted in a timely manner, it is not likely that they will be critical path components of the schedule.

Assuming a 3-month application preparation period for the TPDES permit, the estimated time for the permitting process prior to the start of facility construction is then approximately 21 months for this seawater desalination facility scenario. A 24-month construction period with a 1-month commissioning period were also selected as typical durations, based on previous experience. Consequently, the duration from the start of permitting activities to the end of the commissioning period is estimated to be approximately 46 months.

Conclusion

The Facility features related to the selection of the site, the source of raw water, the concentrate disposal method, and the ancillary systems associated with waste disposal, wastewater

discharges, and air emissions can have significant environmental impacts. As a result, they directly affect: (1) the permits needed; (2) the types, scope, and cost of the environmental investigations needed for the permitting process; and (3) the amount of time required for completing permitting activities. Therefore, the permit requirements should be defined while the early stages of preliminary design are in progress to ensure that design and permitting activities are coordinated.

While the issues associated with permitting seawater desalination facilities using RO processes can be complex and confusing due to the lack of guiding precedent, the roadmap presented herein provides a systematic approach to identify major permit requirements that may be used once basic project features have been defined. However, it should be noted that this tool should only be used to provide initial guidance about major permitting requirements. Consequently, the roadmap is not necessarily definitive and is not a substitute for appropriate consultation and communication with federal, state, county, and local regulatory agencies typically conducted when a permitting plan is formulated. These communication activities are an essential step in any prudent plan for permitting and any successful project development approach. Rather, the roadmap should be viewed as a starting point for a preliminary permitting plan that could be used during initial discussions with the regulatory community.

References

1. SJRWMD, “Technical Memorandum B.6., Applicable Rules and Regulations for Seawater Demineralization,” 2002.
2. Personal communications: Howard Steiman, R. W. Beck, with Anthony Bennett, et al., Texas Commission on Environmental Quality
3. Personal communications: Howard Steiman, R. W. Beck, with Leslie Savage, Railroad Commission of Texas

Table 1
Typical Seawater Desalination Facility Permitting Requirements[1]

Facility Feature	Permit Model	Permit	Reason	Agency	Schedule
Desalination Facility Permits					
1. Surface water intake	Surface Water Permit Model	Water Rights Permit	Source Water Withdrawal	TCEQ	12 months from application
2. Surface water discharge	Surface Water Discharge Permit Model	TPDES	Concentrate & Other Wastewater Discharge	TCEQ	18 months from application: 12 months for TCEQ application review and comments resolution, and 6 months for notice and appeals process
3. Storm water discharge to separate municipal storm sewer	Other Environmental Permit Model	NOI to TCEQ with copy to MS4 Operator	Storm water Discharge to Separate Municipal Storm water Sewer	TCEQ	48 hours from submittal of NOI (provisional coverage subject to wastewater testing)
4. Discharge of dredge/fill material in wetlands for intake and discharge piping construction	Project Development Permit Model	Section 404 Permit	Source Water Withdrawal and Concentrate Discharge Pipelines	USAC	9 months from application – includes 3 months for resolution of comments received from the public
5. New or Modified Public Water System	Project Development Permit Model	Approval for New or Modified Public Water System	Need Assessment and Engineering Review for New Desalination Facility	TCEQ	90 days from the completion of the prerequisites: 30 days for TCEQ Review, 30 days to respond to TCEQ comments, and 30 days for second TCEQ review.
6. Antiquities Review	Project Development Permit Model	Review Letter	Antiquities Impact Assessment	Texas Antiquities Committee	60 days from submittal of notice to the commission
7. New buildings	New Construction Permit Model	Building Permit	New Buildings	Local Agency	30 days from submittal
8. Site work	New Construction Permit Model	Local Erosion Permit	Site Construction	Local Agency	30 days from submittal
9. Tree removal	New Construction Permit Model	Tree Removal Permit	Site Construction	Local Agency	30 days from submittal
10. Local roadway or public way crossings	New Construction Permit Model	Utility Permit	Utility connections	Local Agency	30 days from application
11. Storm water discharge during construction	New Construction Permit Model	TPDES	Storm water Discharge During Construction	TCEQ	48 hours from submittal of NOI (provisional coverage subject to wastewater testing)

Table 1
Typical Seawater Desalination Facility Permitting Requirements(1)

Facility Feature	Permit Model	Permit	Reason	Agency	Schedule
12. Discharge of Water for Hydrostatic Testing	New Construction Permit Model	TPDES	Hydrostatic Test Water Discharge	TCEQ	48 hours from submittal of NOI (provisional coverage subject to wastewater testing)
13. CIP waste disposal via WWTP	Concentrate and Membrane Cleaning Disposal WWTP Permit Model	Local Permit for Disposal via Discharge at Publicly Owned or Other WWTP	CIP Wastes & Sewage	Local Agency	90 days from application

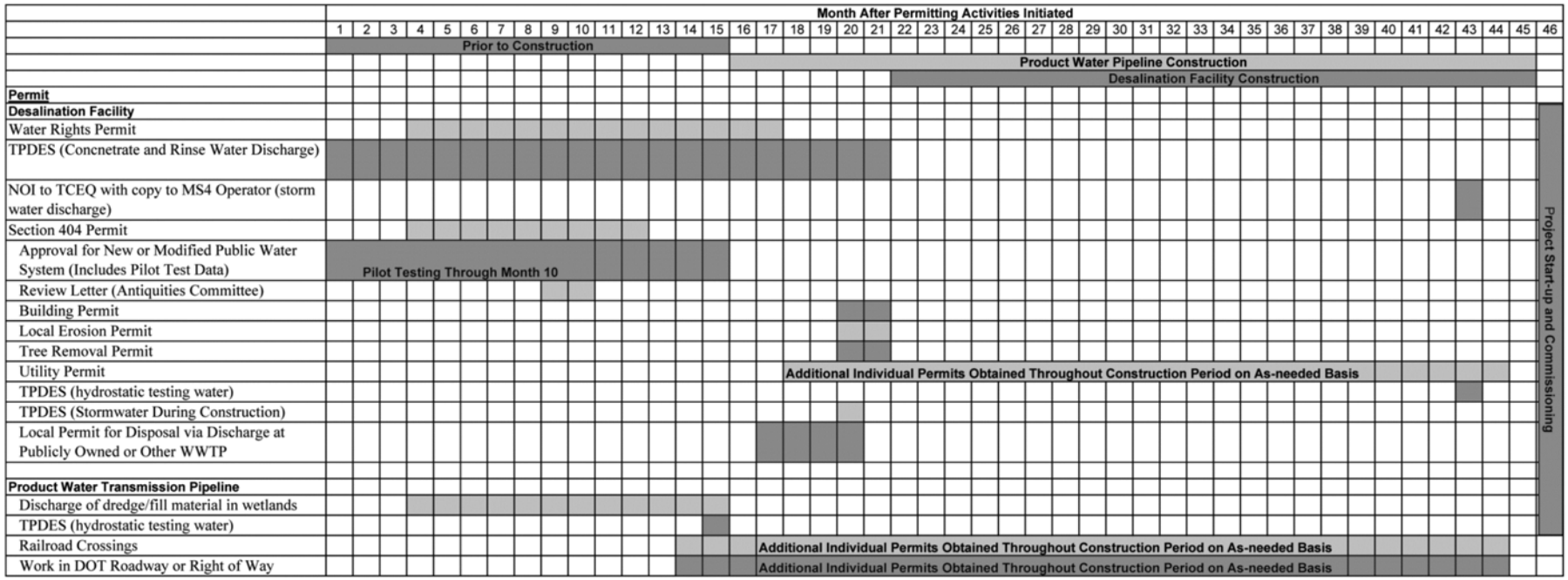
(1) Seawater Desalination Facility co-located with a power plant that uses a once-through cooling system.

Table 2
Typical Product Water Transmission Pipeline Permitting Requirements(1)

Facility Feature	Permit Model	Permit	Reason	Agency	Schedule
1. Discharge of dredge/fill material in wetlands	Project Development Permit Model	Section 404 Permit	Product Water Transmission Pipeline	USAC	12 months from application – includes 6 months for resolution of comments received from the public
2. Discharge of Water for Hydrostatic Testing	New Construction Permit Model	TPDES	Product Water Transmission Pipeline	TCEQ	48 hours from submittal of NOI (provisional coverage subject to wastewater testing)
3. Railroad Crossings	Project Development Permit Model	Pipeline Crossing Permit	Product Water Transmission Pipeline	CSX	60 days from application
4. Work in DOT Roadway or Right of Way	Project Development Permit Model	Utility Permit	Product Water Transmission Pipeline	TXDOT	30 days from application

(1) Seawater Desalination Facility co-located with a power plant that uses a once-through cooling system.

Figure 2
Typical Permitting Schedule for a Seawater Desalination Facility
Co-located with a Power Plant with a Once Through Cooling System



Notes:

1 Assumes permitting activities are initiated in Month 1.

2 Durations shown above include permit application preparation activities.